

Chapter 9 Continuous Monitoring, 2001-2002

Introduction

The Continuous Monitoring Program supplements the Department of Water Resources' monthly discrete Compliance Monitoring Program by providing real-time hourly and quarter hourly water quality and environmental data from seven shore-based automated sampling stations located in the upper San Francisco Estuary (Figure 9-1). These stations provide continuous measurements of seven water quality parameters and four environmental parameters, which are used by operators of the State Water Project and the Central Valley Project to assess the impacts of the project operations and to adjust project operations to comply with mandated water quality standards. The Continuous Monitoring Program has been in operation since 1983. This report summarizes the results of continuous water quality monitoring at seven sites for calendar years 2001 and 2002.

Methods

Continuous data are collected for the water quality and environmental parameters shown in Table 9-1. Each of the seven monitoring stations collects continuous data for water temperature, pH, dissolved oxygen, and surface specific conductance. In addition, chlorophyll fluorescence data is recorded at four locations: two on the Sacramento River (Rio Vista and Mallard Island stations) and two on the San Joaquin River (Antioch and Stockton stations). Additional sensors at the Antioch, Mallard Island, and Martinez stations monitor bottom specific conductance at 1.5 meters above the channel bottom. These measurements, along with river stage data measured at the Mallard and Martinez stations, are needed to determine compliance with the salinity standard (also known as X2) mandated by the Bay-Delta Plan (SWRCB 1995). Environmental data (such as air temperature, solar radiation, wind speed, and direction) are measured at all stations, with the exception of Mossdale (only air temperature) and Hood stations (no environmental data recorded).

Except for bottom specific conductance, all water samples are collected at one meter below the water surface using a float-mounted pump and then distributed to the water quality sensors. A data acquisition, control, and telemetry system (Ocean Data Equipment model DACTS-80-26) scans the output from the sensors once per second and records the hourly average of these approximately 3,600 readings on the hour. Bottom specific conductance and environmental data (such as solar radiation, wind speed and wind direction data) are recorded at 15-minute intervals.

Complete hourly or quarter-hourly data for air and water temperature, pH, dissolved oxygen, surface and bottom specific conductance, and river stage are available from the Interagency Ecological Program database <http://www.wiep.water.ca.gov/dss/all/>. Data for all other measured parameters

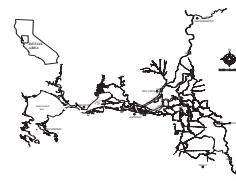


Figure 9-1 Monitoring station locations

are available by request to the Chief of the Real Time Monitoring and Support Section¹.

Table 9-1 Parameters Measured by the Continuous Monitoring Program

| Parameter | Units | Frequency |
|------------------------------|----------------------------|-------------------------|
| Water Temperature | °C | Hourly average |
| Air Temperature | °C | Hourly average |
| Dissolved Oxygen | mg/L | Hourly average |
| pH | unitless | Hourly average |
| Chlorophyll Fluorescence | fluorescence units | Hourly average |
| Surface Specific Conductance | µS/cm | Hourly average |
| Bottom Specific Conductance | µS/cm | 15 minute instantaneous |
| River Stage | feet (from mean sea level) | 15 minute instantaneous |
| Wind Speed | knots/hr | 15 minute instantaneous |
| Wind Direction | degrees | 15 minute instantaneous |
| Solar Radiation | cal/min/cm ² | 15 minute instantaneous |

Results

The monthly averages of the continuous 15-minute or hourly data collected for air and water temperature, pH, dissolved oxygen, surface and bottom specific conductance, and chlorophyll fluorescence for calendar years 2001 through 2002 are shown in Figures 9-2 to 9-8.

Water Temperature

Water temperature was measured in degrees Centigrade (°C) using a Schneider Instruments RM25C-031 Temperature Parametric System.

Monthly average water temperatures in the Estuary for the two-year period ranged from 8.4 °C in January 2001 at the Rio Vista station on the Sacramento River to 26.5 °C in July 2002 at the Stockton station on the San Joaquin River (Figure 9-2).

Average monthly water temperatures at Hood and Rio Vista stations on the Sacramento River were 1° to 2° C lower than the same average temperatures at the inland stations of Stockton and Mossdale on San Joaquin River.

Dissolved Oxygen

Dissolved oxygen was measured using a Schneider Instruments RM25C-033 utilizing a Clark polarographic probe.

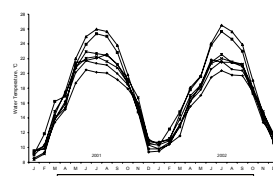


Figure 9-2 Average monthly water temperature at Seven Stations, 2001- 2002

¹ Send written request to: Chief, Real-Time Monitoring and Support Section, Division of Environmental Services, Office of Water Quality, Environmental Water Quality and Estuarine Studies Branch, 3251 S Street, Sacramento CA 95816

Average monthly dissolved oxygen values for the seven monitoring stations ranged from 3.1 mg/L to 13.6 mg/L (Figure 9-3). The greatest degree of variability was seen at the San Joaquin River stations of Stockton and Mossdale. A low monthly average of 3.1 mg/L was calculated for the Stockton station in August 2002, and a high monthly value of 13.6 mg/L was calculated for the Mossdale station for July 2002. All other stations showed monthly averages between 7.7 mg/L and 10.6 mg/L. All compliance monitoring stations, except the Stockton station, recorded values above the standard of 5.0 mg/L set by the Central Valley Regional Water Quality Control Board in the Basin Plan (CVRWQCB 1998). Average monthly dissolved oxygen values at the Stockton station were highly variable, and ranged from 3.1 mg/L to 8.5 mg/L.

During the summer and fall of both study years, monthly average dissolved oxygen values at the Mossdale station were exceptionally high. Dissolved oxygen during the months of June and July 2001 ranged from 12.3 mg/L to 12.5 mg/L. Average monthly dissolved oxygen values in 2002 showed a similar pattern from June to September, ranging from 12.5 mg/L to 13.6 mg/L. The high average summer DO levels seen at the Mossdale station coincided with high chlorophyll fluorescence during the same period.

Specific Conductance

Specific conductance was measured using a Schneider Instruments RM25C-032 measuring system.

Average monthly surface specific conductance for the Estuary for the two-year period ranged from 168 $\mu\text{S}/\text{cm}$ to 31,000 $\mu\text{S}/\text{cm}$, with the lower values in the Sacramento River at Hood and the higher values at the more tidally influenced Martinez station (Figure 9-4a). Data taken from the Mossdale and Stockton stations on the San Joaquin River show a higher average specific conductance than the stations of Hood and Rio Vista on the Sacramento River (Figure 9-4b). For clarity, these data are shown separately in Figure 9-4b.

Bottom specific conductance measured at the Antioch, Mallard Island, and Martinez stations exhibited seasonal patterns and ranges similar to the surface specific conductance (Figure 9-5).

pH

A Schneider Instruments RM25C-035 measuring system was used to measure pH.

Monthly average pH levels for the Estuary for the two-year period at all stations ranged from 7.3 to 8 pH units, with the exception of Mossdale where pH values in June, July, August, and September ranged from 8.3 to 8.9 pH units (Figure 9-6). This increased pH coincided with high chlorophyll fluorescence observed at Mossdale during the same period.

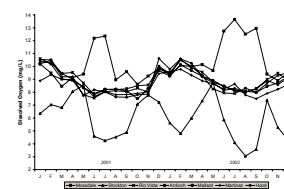


Figure 9-3 Average monthly dissolved oxygen at seven stations, 2001-2002

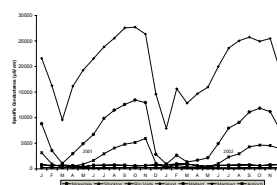


Figure 9-4a Average monthly surface specific conductance at seven stations, 2001-2002

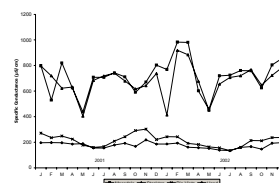


Figure 9-4b Average monthly surface specific conductance at four stations, 2001-2002

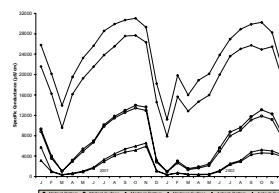


Figure 9-5 Average monthly surface and bottom specific conductance at three stations, 2001-2002

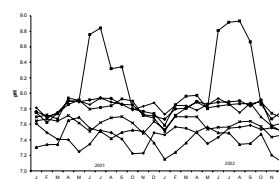


Figure 9-6 Average monthly pH at seven stations, 2001-2002

Air Temperature

Air temperature was measured using a Schneider Instruments RM25C-036 measuring system.

Monthly average air temperatures in the Estuary for the two-year period ranged from 6.7 °C in January 2001 at the Stockton station on the San Joaquin River, to 24.4 °C at the Mossdale station on the San Joaquin River (Figure 9-7). A 1°C average temperature drop occurred from March to April 2001 at all stations except Martinez.

Chlorophyll Fluorescence

Chlorophyll fluorescence was measured using a Turner Designs Model 10 Fluorometer set-up with a continuous flow system using chlorophyll *a* filters.

Monthly average chlorophyll fluorescence was recorded at four continuous monitoring stations in the Estuary: one station on the Sacramento River at Rio Vista, and three on the San Joaquin River at Mossdale, Stockton, and Antioch (Figure 9-8). The recorded values ranged from 8.5 fluorescence units (FU) on November 2001 at the Rio Vista station on the Sacramento River, to 229 FU on August 2002 at the Mossdale station on the San Joaquin River.

Stockton Ship Channel Dissolved Oxygen

As part of DWR's mandate for monitoring water quality in the Delta, a special monitoring study is focused on dissolved oxygen conditions in the Stockton Ship Channel from Prisoner's Point to the Stockton turning basin (See Chapter 7). Continuous data from a monitoring station in the ship channel (Stockton Station #20) supplements monthly discrete sampling, and alerts DWR personnel when dissolved oxygen levels become critical.

The Central Valley Regional Water Quality Control Board has established a baseline objective of 5.0 mg/L for the entire Delta (CVRWQCB 1998); however, due to the special need in the Stockton Ship Channel to protect fall-run Chinook salmon, a DO objective of 6.0 mg/L has been established for September through November by the State Water Resources Control Board (SWRCB 1995).

For the year 2001, average monthly DO values at the Stockton station remained above the 6.0 mg/L objective during October and November, but fell below 6.0 mg/L in September (Figure 9-9). In 2002, average monthly DO levels were above the 6.0 mg/L standard in October, but were below the objectives in both September and November (Figure 9-10).

Hourly DO values ranged from 2.3 to 12.8 mg/L in 2001. The lowest DO values occurred from June through September, with values well below the State objectives. Monthly average DO values were also well below the standards during these months. In 2002, hourly values ranged from 1.2 to 11.9 mg/L. The minimum value of 1.2 mg/L recorded in July 2002 was the lowest value recorded in the last five years. Similar to 2001, the lowest DO levels in 2002 also occurred during the summer months of July, August, and

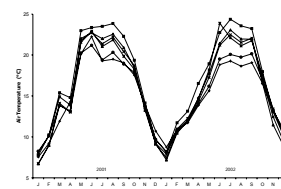


Figure 9-7 Average monthly air temperature at six stations, 2001-2002

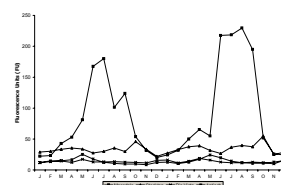


Figure 9-8 Average monthly chlorophyll fluorescence at four stations, 2001-2002

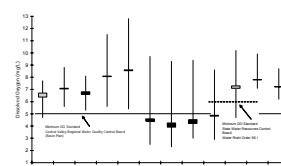


Figure 9-9 Hourly and average monthly dissolved oxygen. San Joaquin river at Stockton, 2001

September; however, DO levels were much more variable, and low monthly and hourly DO levels occurred in winter months as well. The pattern of falling in DO levels in the winter was seen to a lesser degree in the 2001 data, and continues a trend that was first observed in 2000.

The box plots (Figure 9-9 and 9-10) show the maximum and minimum range of average hourly DO values for the month, along with monthly medians and averages. Horizontal “whiskers” indicate the range of hourly DO values for each month. Boxes represent monthly medians and averages. Open boxes indicate that the monthly median is greater than the monthly average, with the top of the box indicating the median, and the bottom of the box indicating the average. Filled boxes indicate that the monthly average is greater than the median, with the top of the box indicating the average and the bottom of the box indicating the median. A horizontal dashed line indicates that the median and the average are equal.

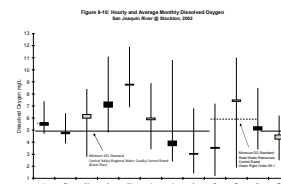


Figure 9-10 Hourly and average monthly dissolved oxygen. San Joaquin River at Stockton, 2002

Summary

Water quality conditions in the upper San Francisco Estuary for the calendar years 2001 and 2002 were in the expected range of values for water temperature, dissolved oxygen, specific conductance, pH, air temperature, and chlorophyll *a* fluorescence at the Sacramento River stations. The exceptions were found on the San Joaquin River.

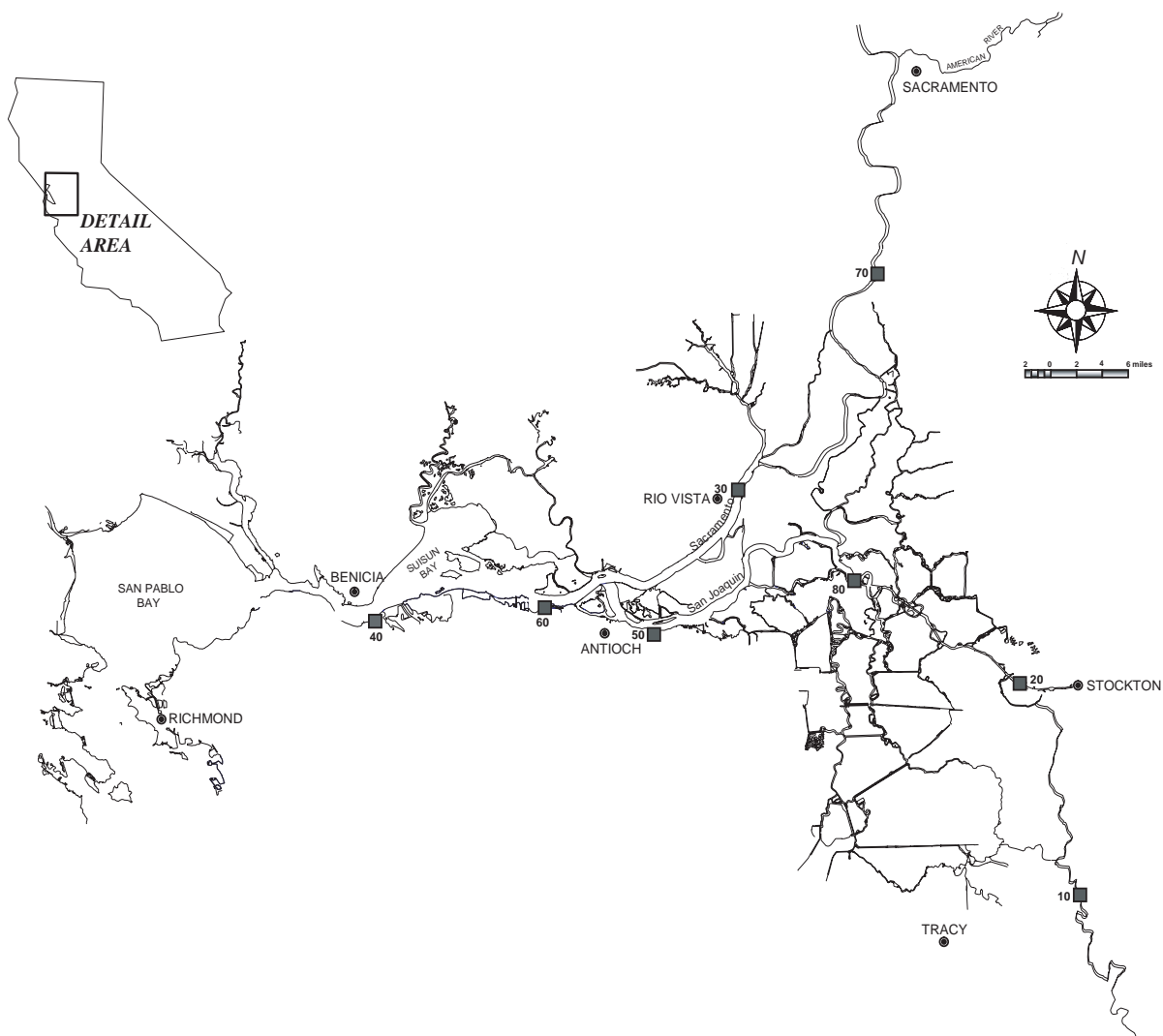
The San Joaquin River station at Mossdale showed higher dissolved oxygen, pH, and chlorophyll *a* fluorescence values during the months of June, July, August, and September, as compared with other stations in the Estuary. Dissolved oxygen levels ranged from 12.3 to 13.6 mg/L. The pH values ranged from 8.3 to 8.9 pH units, and chlorophyll *a* fluorescence values ranged from 101 to 229 FU.

The San Joaquin River station at Stockton, unlike other stations in the Estuary, showed a dissolved oxygen sag below the 5.0 mg/L state objective (CVRWQCB 1998) for the months of June, July, and August 2001 and 2002, as well as a second sag below 5.0 mg/L in November and December 2002.

References

- [CVRWQCB] Central Valley Regional Water Quality Control Board. 1998. *Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board Central Valley Region, the Sacramento River Basin, and San Joaquin River Basin*. Fourth Edition.
- [SWRCB] State Water Resources Control Board. 1995. *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Estuary*. Adopted May 22, 1995, pursuant to Water Right Order 95-1. Sacramento, CA. 44pp.

Figure 9-1 Monitoring Station Locations



| Station # | Location | IEP HEC-DSS database ID |
|-----------|---|-------------------------|
| 10 | San Joaquin River at Mossdale | RSAN087 |
| 20 | San Joaquin River at Stockton | RSAN058 |
| 30 | Sacramento River at Rio Vista | RSAC101 |
| 40 | Sacramento River at Martinez | RSAC054 |
| 50 | San Joaquin River at Antioch | RSAN007 |
| 60 | Sacramento River at Mallard Island | RSAC075 |
| 70 | Sacramento River at Hood | RSAC142 |
| 80 | San Joaquin River at Prisoners Point (seasonal station) | RSAN037 |

Figure 9-2 Average monthly water temperature at seven stations, 2001-2002

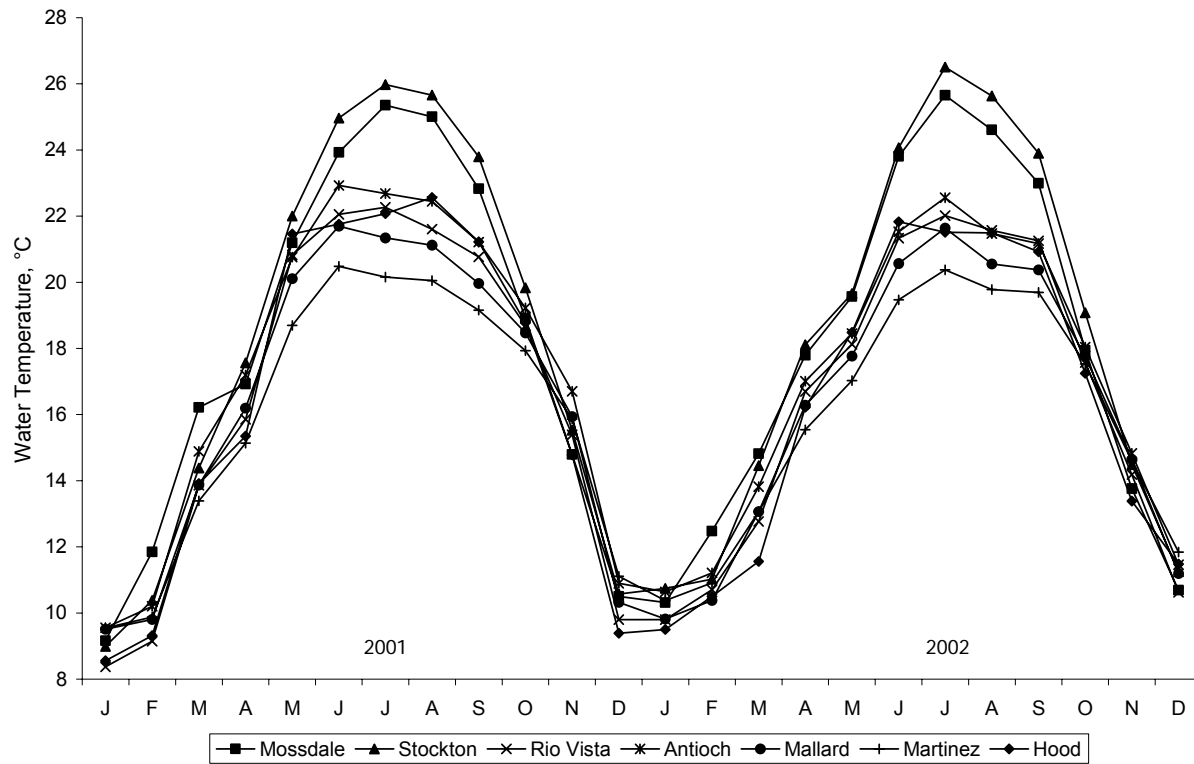


Figure 9-3 Average monthly dissolved oxygen at seven stations, 2001-2002

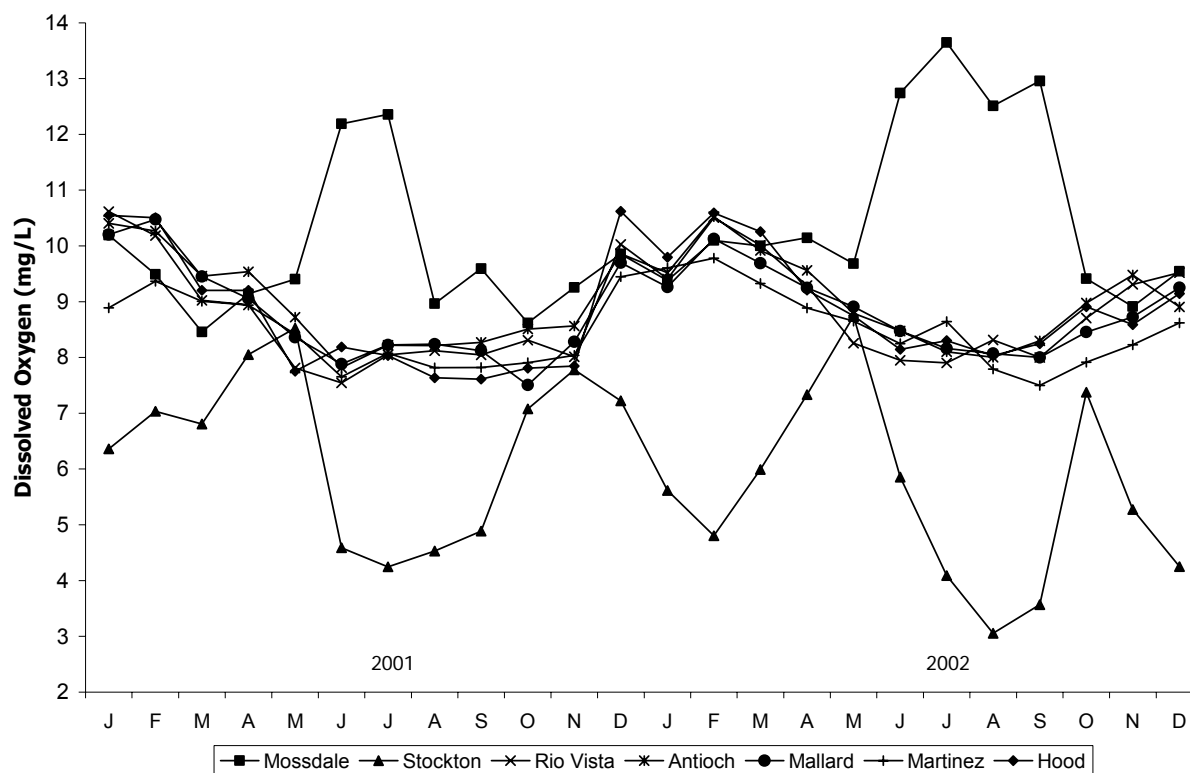


Figure 9-4a Average monthly surface specific conductance at seven stations, 2001-2002

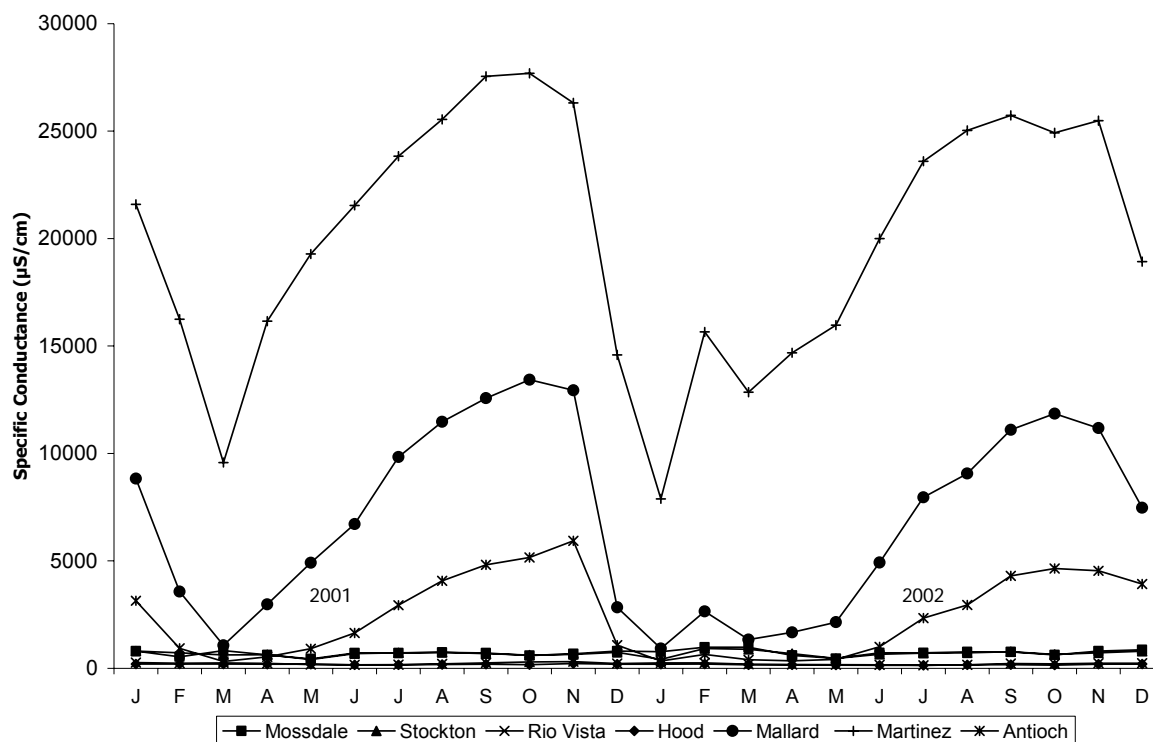


Figure 9-4b Average monthly surface specific conductance at four stations, 2001-2002

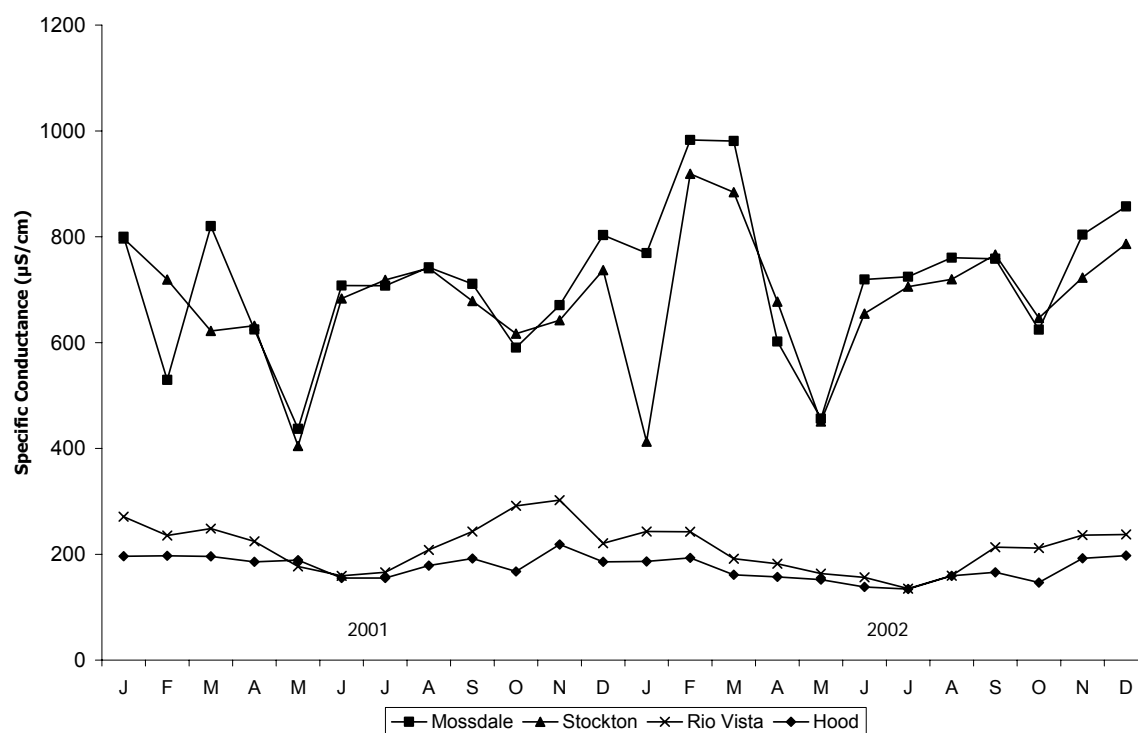


Figure 9-5 Average monthly surface and bottom specific conductance at three stations, 2001-2002

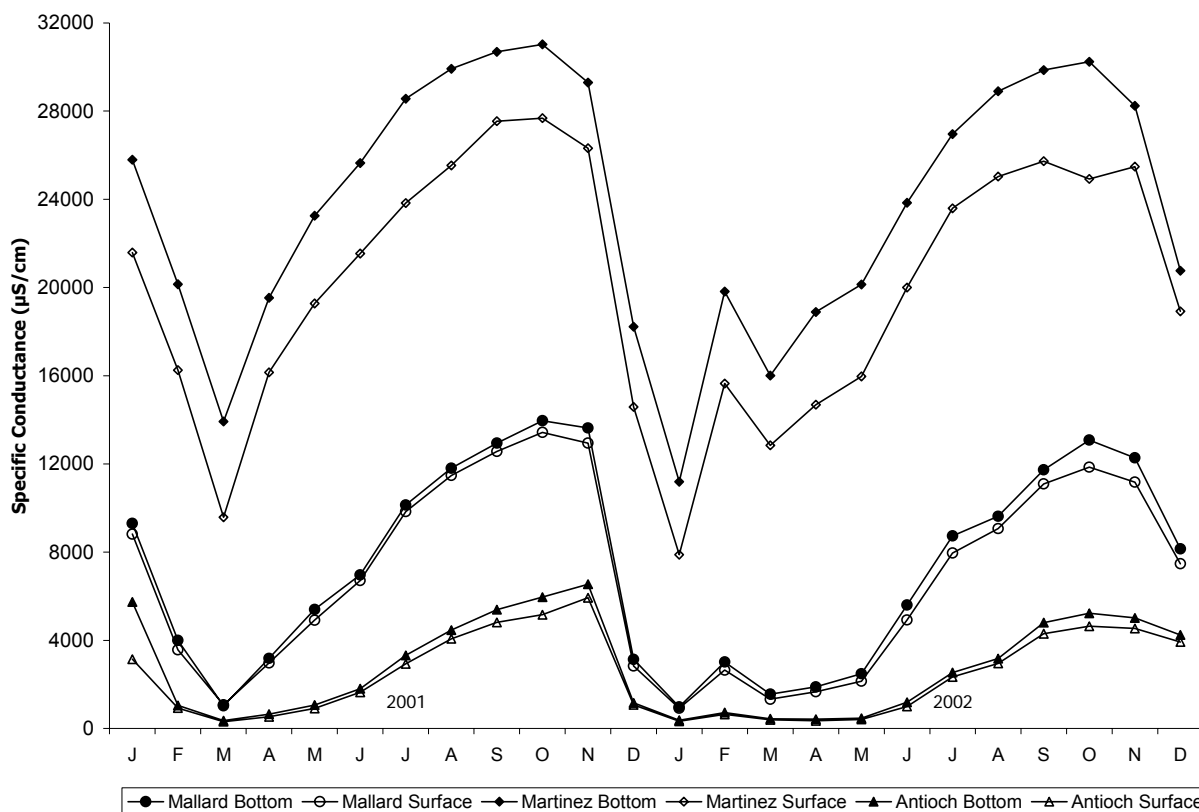
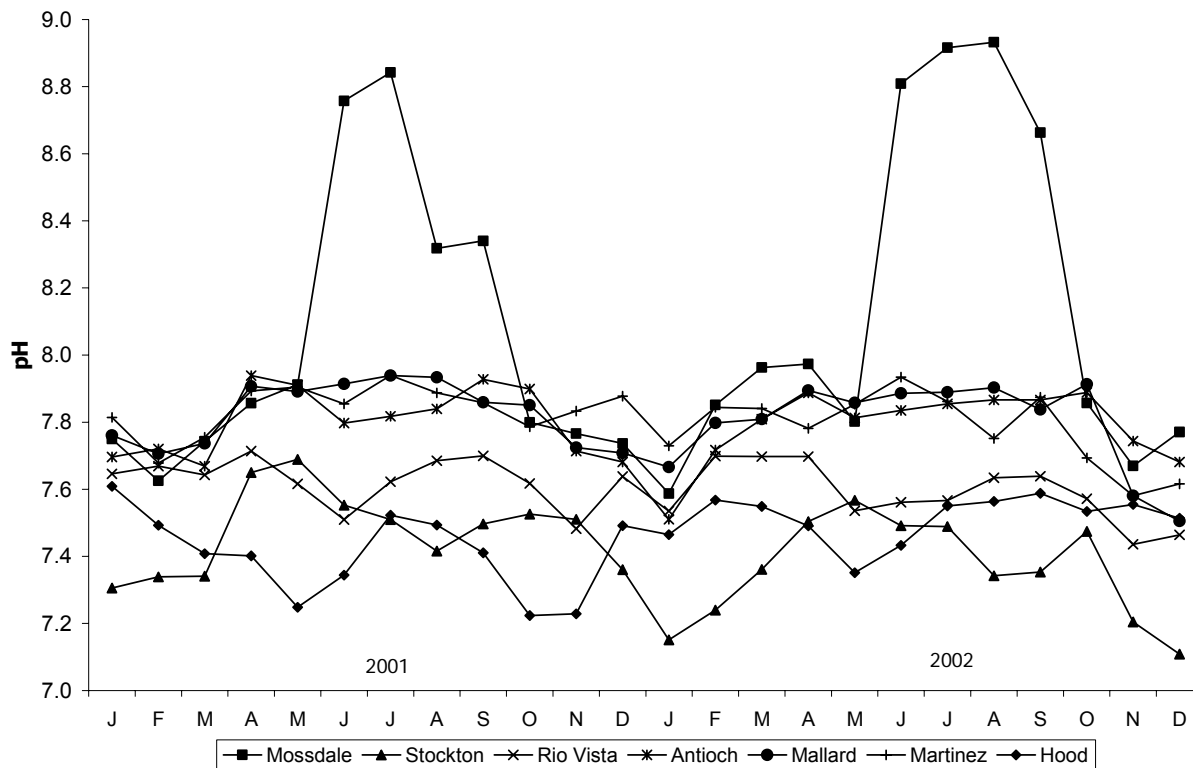


Figure 9-6 Average monthly pH at seven stations, 2001-2002



**Figure 9-7 Average monthly air temperature at six stations,
2001-2002**

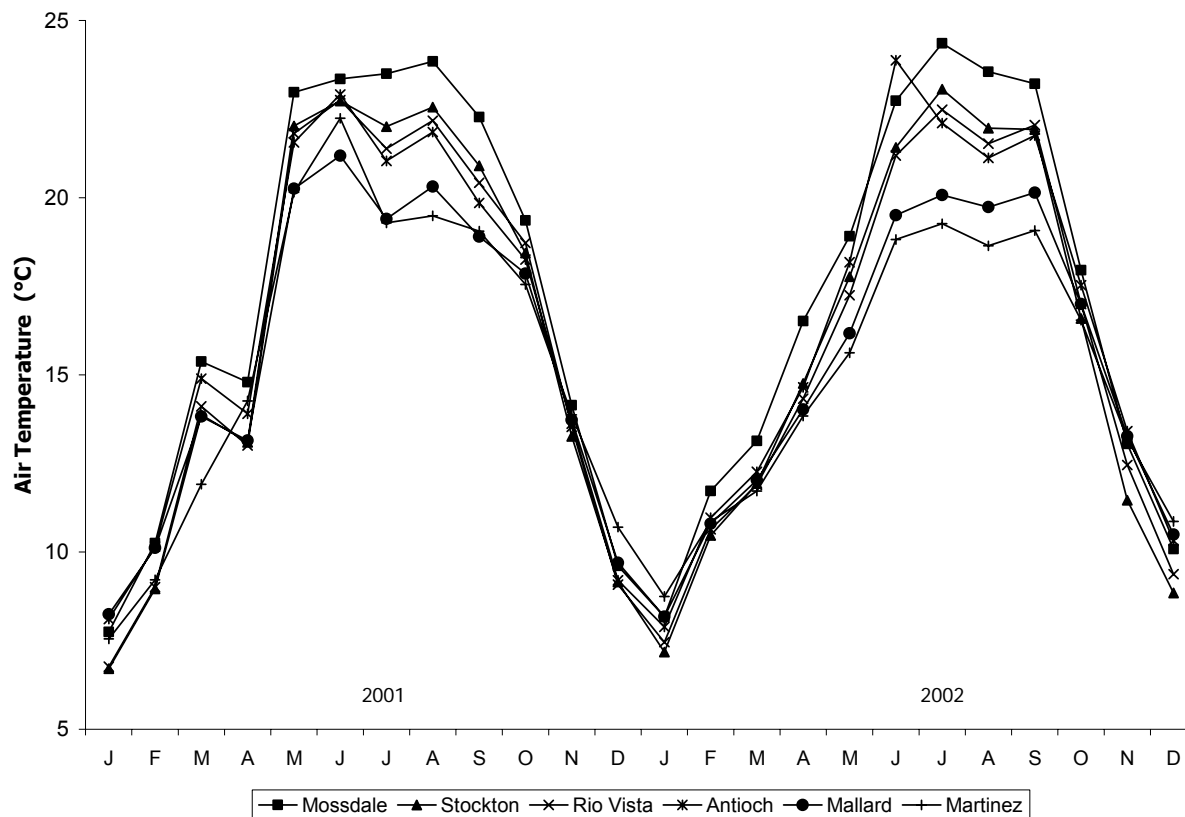
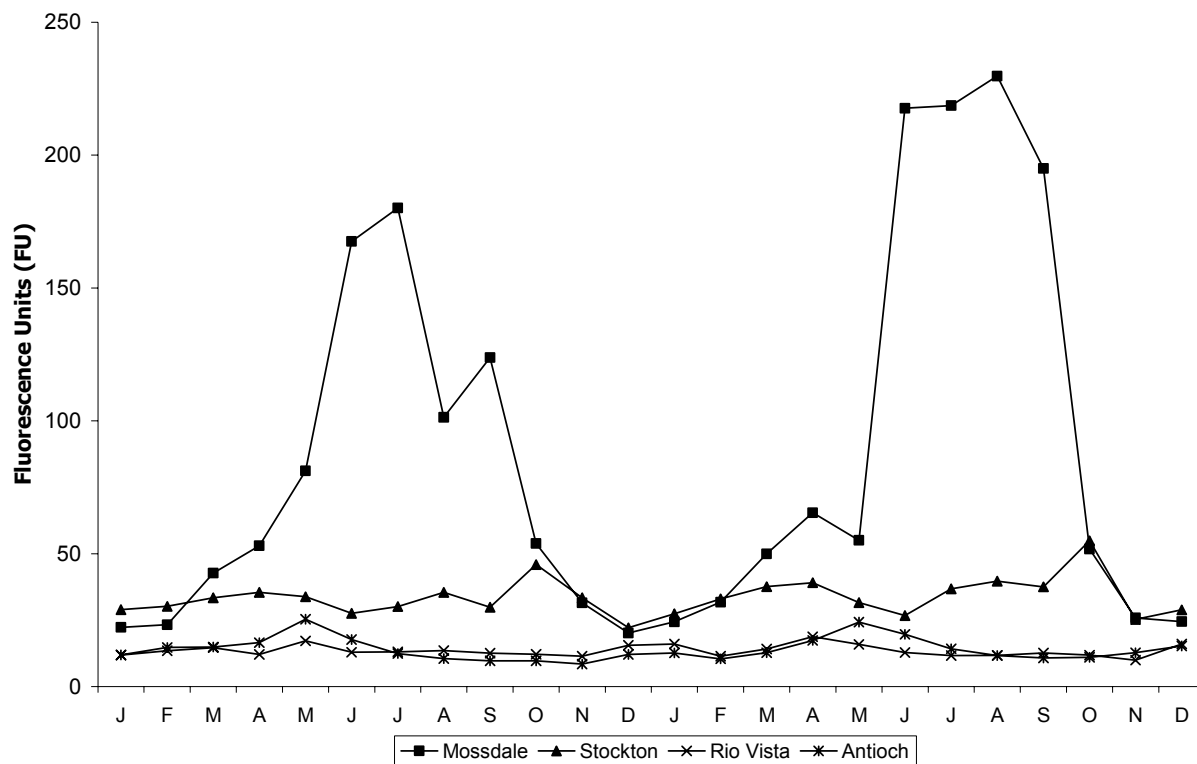
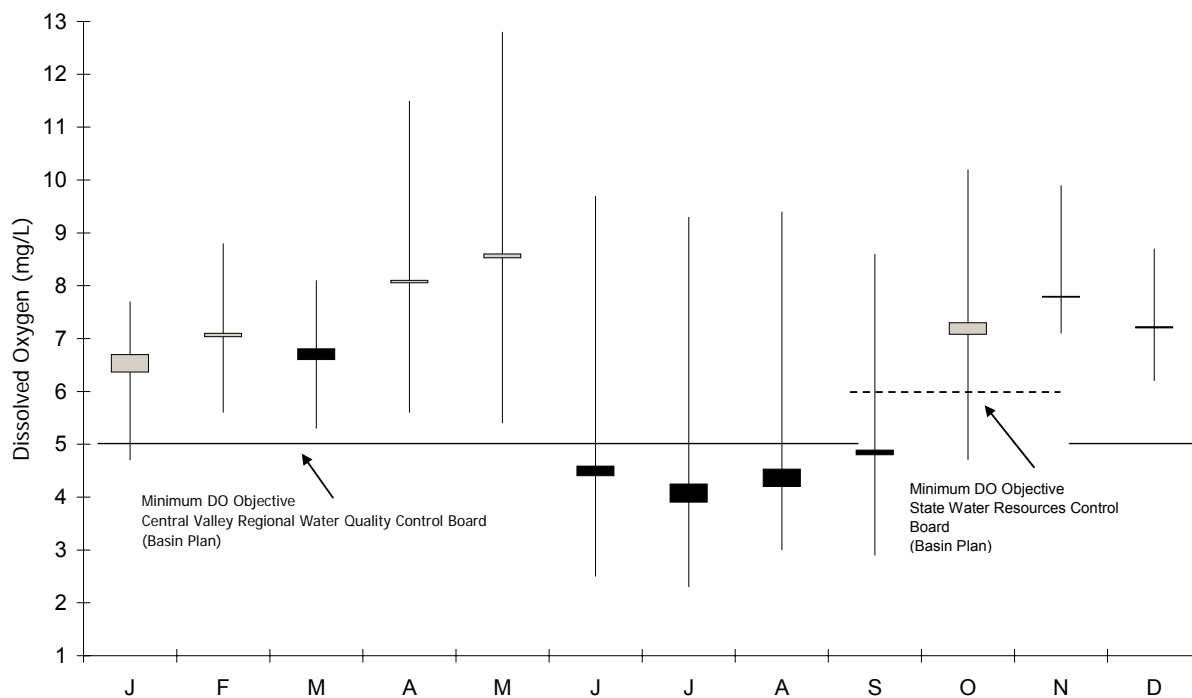


Figure 9-8 Average monthly chlorophyll fluorescence at four stations, 2001-2002



**Figure 9-9 Hourly and average monthly dissolved oxygen.
San Joaquin River at Stockton, 2001**



**Figure 9-10 Hourly and average monthly dissolved oxygen.
San Joaquin River at Stockton, 2002**

